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ABSTRACT

Activity theory is a perspective that is largely rooted in the writing of Soviet psychologists. One of the premises of the theory is that human behavior and thinking occur within meaningful contexts as people conduct purposeful goal directed activity. The primary unit of psychological study should be socially organized human activity, rather than mind or behavior alone. To exemplify this, ethological studies of wayfinding which investigate the use of spatial knowledge in naturalistic contexts are cited, and the use of cultural tools and practices in spatial problem solving is discussed. Several issues relevant to spatial cognition are considered in terms of their relation to Gladwin's study of spatial problem solving among traditional Puluwat navigators. Suggestions on ways of incorporating activity theory in research on the development of spatial thinking are offered. It is noted that one direction of study concerns the investigation of the development and use of materials and social resources in the structuring of spatial problems and the ways developmentalists go about solving them. Another direction involves the examination of spatial thinking in relation to task structure and goals. A final direction involves researchers' queries about what skills develop and the manner in which they develop. A list of 24 references is included. (BC)

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The Development of Spatial Thinking in Everyday Activity

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This paper is dedicated to Sylvia Scribner who taught me so much about activity theory. I am grateful to Barbara Rogoff for her interest and involvement in this work over many years. The paper was presented at the biennial meeting of the Society for Research in Child Development in the symposium "Where do we go now? Understanding the development and use of spatial thinking in problem-solving contexts." April, 1991, Seattle, WA.

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About four years ago, or more precisely two SRCDs ago, I attended a symposium at these same meetings on the development of spatial thinking. The panel included several respected scholars who were, in various ways, studying this development. Despite an impressive presentation of empirical findings, all of which revealed some aspects of these developing competencies, the researchers, as a whole, appeared to reflect a sort of theoretical *angst* about their work and about the enterprise in general. This *angst* is also evident in a recent book by Christopher Spencer, Mark Blades, and Kim Morsley (1989), who lament the fact that research in spatial cognition has yet to yield a coherent conceptualization of key issues. Lynn Liben, who served as discussant of the aforementioned SRCD papers, noted this sentiment and remarked that she, unlike her colleagues, did not share in it. She explained that she has a theory, Piagetian theory to be exact, and that this theory serves her well in her investigations of the development of spatial cognition. I found this comment intriguing at the time, and have reflected on it since. Not only did it seem rather comforting in the face of a conglomeration of rich data and little overarching explanatory integration, but it reminded me of a nagging truism from my graduate training, that is, of the utility of theory in guiding both our questions and our understanding in psychological study.

In this paper I am going to follow Liben's lead by commenting that I too have a theory that guides my thinking and research about the development of spatial thinking. Like Liben, I believe my theoretical perspective holds promise for studying this development, but unlike Liben, I will not be talking about Piagetian theory. Rather I am going to talk about the role of *activity theory* in the study of the development of spatial cognition. Before I discuss this perspective and try to persuade you of its utility in this area of study, I want to make it clear that I am not proposing that this theory be embraced and others discarded. In fact, I am of a mind

that no single theoretical framework will answer all the questions we have in psychology, either in general or in any specific area of study. Many avenues of investigation are needed, and at this early stage of understanding it would be foolhardy indeed to put all of our thinking in one basket, so to speak. We have much to learn from a pluralism of approaches and from each other. What I will propose is simply a framework for researching a particular set of spatial problems. If this perspective is found at some future point to have more far reaching utility, all the better. For now, I find this way of thinking useful and my purpose is to explain why.

Activity theory is a perspective that for developmentalists is largely rooted in the writings of Soviet psychologists, such as Vygotsky (1978), Leont'ev (1981), Zinchenko (1981), and others (see Wertsch, 1981). There are other theoretical perspectives that resonate with this view, I refer primarily to *action theory* (e.g. see Frese & Sabini, 1985), which is currently more prevalent in Europe than the U. S. But I will focus on my reading and understanding of Soviet activity theory, although I hope what i say meshes with related views.

One of the important premises of activity theory is that human behavior and thinking occur within meaningful contexts as people conduct purposeful goal directed activity. This theory proposes that neither mind nor behavior alone should be the primary unit of analysis in psychological study. Rather, the primary unit of study should be socially organized human activity. This perspective has been discussed extensively by Barbara Rogoff (1990), Sylvia Scribner (1986), James Wertsch (1981), and others, and thanks to their writings, I need not describe it extensively here. What I shall concentrate on is how this perspective may contribute to the study of the development of spatial thinking.

From an activity theory perspective, knowledge about large-scale space is embedded within a rich context of meaning. Thus, in order to understand the organization and development of this knowledge it is important to consider it within

this contextual frame, a frame which includes the individual and sociocultural history of the actor, the structure of the task, in particular the task goal and materials, and the relationship of these psychological and task factors to one another. There is some research in the spatial cognition literature that bears a resemblance to this view, although it is not based on activity theory. I am referring here to studies of wayfinding that are influenced by ethology, such as David Olton's (1978) comparative research and Edward Cornell and Donald Heth's (1983) human developmental research. In these investigations we see interesting and informative attempts to understand the use of spatial knowledge in naturalistic contexts and problem solving. The strength of this work is in its insistence on investigating spatial thinking both within the ecological niche in which organisms live and within the context of meaningful problem solving activity. But despite this strength, there is an inherent limitation in this perspective that restricts its utility in addressing a large portion of the everyday spatial problem solving in which humans engage. Perhaps due to its origins in the study of animal behavior, ethological theory, although focused on activity, does not consider the contribution of social and cultural factors to the organization of thinking and acting. Humans, like other organisms, do solve problems in space. But unlike other organisms, humans participate in the development and use of a panopoly of cultural tools and processes that not only provide assistance in solving these problems, they also help define the very way we understand and characterize these problems. Let me explain.

Most everyday spatial problem solving fits into one of two types. We are either conveying in fairly explicit terms our knowledge of a space to someone else, e.g. when we give directions or describe a place, or we are solving a problem that, even though knowledge of the space may not be the goal of the activity, the problem requires that at least to some degree we understand and use large-scale space, e.g. planning and carrying out a series of errands downtown. Both of these types of everyday spatial

activity rely on a number of skills, many of which reflect the sociocultural context in which the activity is performed. For example, when we describe or solve a problem in large-scale space we often employ material aids or tools, such as maps, and communicative conventions, such as route descriptions, that help us accomplish the task. Cole and Griffin (1980) refer to tools, like maps, as cultural amplifiers, that is, techniques or technological features provided by a culture that alter the approaches individual members of the culture use in solving problems posed by their environments. Gauvain and Rogoff (1989) characterize communicative conventions, like route descriptions, similarly, and suggest that much of what is involved in everyday spatial thinking may be related to the development and use of such tools and communicative conventions. In other words, the development and use of spatial thinking in everyday contexts may relate in important ways to the sociocultural context and its accompanying opportunities for developing these skills. Cognitive opportunities resulting from participation in the tools, conventions, and practices of a culture facilitate the development of thinking in that it is through the use and appropriation of these tools and practices that individuals develop thinking skills (Rogoff, 1990). From this perspective, cultural tools and practices are intricately and inextricably related to thinking and its development.

In terms of the development of spatial thinking, what kinds of tools might we be talking about? Certainly material resources are important facilitators for thinking about space. For example, we are all, I hope, aware and grateful for the existence of pencil and paper in facilitating our ability to provide directions. Tools such as these amplify our cognitive capabilities by allowing us to describe large-scale space in ways that would not be possible without the existence of pencil and paper and use of these tools. However, the important point is not that these tools enhance thinking, although in some cases they clearly may do so, e.g. I undoubtedly have fewer lost or frustrated visitors to my home on those rare occasions when I have sent a map prior

to the visit. But, more importantly, these tools may transform our thinking. For example, how I listen when I attend to directions that contain many items to remember differs depending upon whether or not I have a pencil and paper at hand. The availability of these tools structures how I attend to and remember this information, in other words, the cognitive processes that I employ in carrying out the cognitive activity. Yet notice that I cannot take advantage of these tools without the accompanying skill of literacy, a cultural practice that structures how I handle cognitive opportunities such as this when they arise. I participate in literacy because it is a practice commonly engaged in, valued, and transmitted in my culture. And I became literate through the guidance and assistance of others, both in their real social form, as teachers, parents, older siblings and friends, as well as in their material form, in books and writings from which I was able to learn "on my own", whatever that means.

This description of cultural tools and practices has taken on a rather pedantic tone, and for this I apologize. However, I would like you to observe that what I am referring to as tools and practices has spread and now includes both material and social sources, as well as material representations of social sources, i.e. books. And in addition to these, conventional ways of displaying and communicating this knowledge are also included. Such conventions are evident in social structural considerations, such as in specifying who can talk to whom and how and when, as well as in the format of presenting knowledge, such as how one organizes the information being conveyed. In sum, cultural tools, practices, and conventions organize and convey knowledge that is important for cultural members to know and use in their everyday lives and interactions. In this way they provide opportunities for the development of cognitive processes, such as approaches to solving spatial problems.

For Vygotsky and other activity theorists, developing competence at using the tools and participating in the practices and conventions within a sociocultural

context is an important developmental achievement, one that has obvious linkages to the development of cognitive skill like everyday spatial thinking and problem solving. Consider once again the example above. If a person gives directions to someone and has a pencil and paper available, is comfortable and willing to use these, and is describing how to get to a place that is both familiar and describable, the approach to solving this problem is quite different than if any of these conditions is not present. Or consider another example, if one knows how to use a map or navigational tool of some sort, extensive travel will not just be more successful, it may actually be more likely. Remember the Puluwat navigators described by Thomas Gladwin (1971) and the great distances they traveled using star paths and a traditional navigational system. Or consider a more familiar case. Anyone who has tried to arrange a backpacking trip and has had to revise it after the ranger, rather innocuously, says "it's not on the topo map" has acknowledged the intricate relationship between tool and process. Undoubtedly many a trip and perhaps a relationship or two have been lost not heeding what this comment signifies, that is, that the tool and the travel are not independent, they are merged. However, in research we typically consider one side of this problem solving effort, the spatial thinking part, as being inside the head, and the other side, the map, as being outside the head, and the bulk of our labor as psychologists has been in examining the former. But this division artificially obscures the fact that the thinking and the tool are part of the same problem solving process. To describe spatial problem solving by talking about one and not the other is to ignore part of the problem solving process itself, along with factors that may have influenced the development and organization of these skills.

To explore this point further I turn to an observation about the role that a well-known example from anthropology has played in psychological investigations of spatial thinking. I refer again to Gladwin's (1971) ethnography of expert spatial problem solving among traditional Puluwat navigators. Gladwin's descriptions

justifiably astonish outsiders, and this may, in part, explain their ubiquitous citation in the spatial cognition literature. The spatial problems these navigators work on are cognitively taxing to learn, and physically and mentally demanding, sometimes even life threatening, to carry out. However, despite the obvious affection among spatial researchers for this study and the cognitive processes it implies, it seems out of place in this literature given the limited influence it has had on empirical approaches in the field. My question is why has its influence been so limited?

Perhaps this is a consequence, as Spencer, Blades, and Morsley (1989) suggest, that too much of spatial cognition research has focused on conceptual development rather than on the development of children's own sources of information about the world and how they come to know and use this knowledge. Of course, spatial cognition research is not alone in these regard. Much of cognitive developmental research, as Deanna Kuhn observes (1990), concentrates on the origins of discrete cognitive skills rather than on the coordination and explicit use of these skills during problem solving. Obviously developmentalists are and should be concerned with both, but in many domains of study including the development of spatial thinking, investigations of the latter have lagged well behind the former. Furthermore, the integration of spatial thinking with other cognitive skills that develop coincidently, such as social and communicative competence, is poorly understood. Finally, the absence of a general theoretical perspective linking cultural context and individual learning and development may also play a role. Again, this problem is not unique to research in spatial cognition. Cultural and physical settings are understudied in developmental research. This lack of attention reflects the longstanding practice of separating the cultural, physical, social, emotional, and cognitive contexts of development, a practice that has resulted in a disjointed view of how children come to understand and function in the world in which they grow. This disjointed approach has led to the isolation of many areas of investigation, including the study of spatial

cognition, from others, resulting in a less than optimally useful picture of development. Recent research concerned with the role of context and culture in development, such as by Michael Cole (1988) and Barbara Rogoff (1990), attempts to address this very problem, and offers much promise in this regard.

In raising this issue, my goal is not to discourage spatial researchers from reading or citing research such as Galdwin's. On the contrary, my goal is to encourage spatial researchers to read this work more, but perhaps to read it differently, with an eye towards the types of questions and studies that need to be done in order to explain how these navigators develop and use their spatial skills. From an activity theory perspective, such analysis is quite feasible given Gladwin's attention to the navigators' use of tools, both social and material, in organizing and implementing spatial plans and actions. In fact, this work is an excellent treatise on the incorporation of cultural tools, cultural conventions of instruction and communication, and cultural goals of trade and movement in orchestrating a comprehensive and effective spatial problem solving approach.

Yet it seems to me that, in many fundamental ways, what he describes is not wholly unlike much of everyday spatial thinking, especially within local, familiar space where we develop and frequently use these skills. In traditional navigation, like much of everyday navigation, updating of information is perceptually based and is a critical component of being oriented. The remarkable skill of traditional Puluwat navigators relies on knowing many star paths which define courses among islands. And like our knowledge of familiar local space, star paths are not fixed map routes or action sequences, but a reservoir of possible action plans for solving navigational problems. Locomotion, either real and imagined, provides information about landmarks and actual or potential routes, as well as the cues to update and adjust spatial orientation and route finding. And in still other ways, everyday spatial problem solving may be similar to these navigational procedures. It too draws upon

and integrates many cognitive skills, including perception, memory, communication, and problem solving, and it is used flexibly in the course of defining and structuring unique problems and solutions as the need arises.

From this perspective, spatial knowledge and thinking are characterized more like a mental process akin to problem solving than a mental entity such as a representation. And it is in this way that an activity based view, which seems fruitful for characterizing much of what both Puluwat and everyday navigators do, stands in constrast to a representational view of spatial knowledge. From an activity theory view, spatial understanding may not be a general, underlying and internalized piece of knowledge that exists inside the head and is externalized for use when needed (Gauvain & Rogoff, 1983, 1989). In other words, spatial understanding may not be separate from the activity in which the knowledge is used, and thus may be less like a representation, such as a route or a map, and more like a problem solving process.

Given this perspective, how might we incorporate, in more specific terms, an activity theory view in research on the development of spatial thinking? I shall offer some suggestions, illustrated by research. One possible direction is the investigation of the development and use of material and social resources in structuring the spatial problems we have and the ways we go about trying to solve them. Such questions are embedded in recent research by DeLoache (1989), Liben and Downs (1989), and Uttal and Wellman (1989) on the development and use of map reading skills, and by Gauvain and Rogoff (1989) and Elicker, Craton, Plumert, and Pick (1987) on the development and use of cultural conventions for communicating spatial knowledge. Although these researchers differ in the extent to which they consider the development and use of these tools and practices in relation to the sociocultural context of development, questions derived from activity theory may easily be built on such research. For example, research on the development of map reading skills has been primarily

concerned with how and when children understand and can use the symbolic representations that appear in maps in relation to real places and objects in space. Using activity theory, we could also ask whether the development of these skills reflect particular cognitive opportunities in a culture, and whether this skill affects the development or manifestation of spatial thinking more generally, i.e. outside the specific domain of map reading and use.

Another potential direction of study is the examination of spatial thinking in relation to task structure and task goals, investigations that may increase our understanding of how the physical environment, human activity, and intellectual functioning work together in everyday spatial problem solving. For example, Gauvain and Rogoff (1986) found that children's knowledge of large-scale space was influenced by the purpose of exploration of the space, and Scribner, Gauvain, and Fahrmeier (1984) demonstrated that workers in a milk processing plant relied on their extensive spatial knowledge of the plant to shape their work assignment so that it was more adapted to human needs. Yet another direction of research is in the examination of how an individual's daily activities or experiences may contribute to the development and organization of spatial skill. For example, consider research conducted by Lee and Ruth Munroe (1971) in Kenya. The Munroes found a relationship between the distance children played from their village and their skill on spatial tasks. And research by Gauvain and Klaue (1989) that examined the directions provided by employees of the New York City Public Library to patrons of the library indicates that type of experience, but not length of employment, in that setting was related to the nature and the usefulness of the directions provided. (For your information, security guards provide more extensive and more effective directions, in terms of the number of decision points anticipated and resolved, than librarians seated at the information desk by the entryway. The typical librarian directions seemed geared toward getting the patron as far away from the information desk as

possible.) These studies suggest that prior experience in a setting, as defined by functional activities in that setting, may be an important aspect of a spatial problem solving context. Taken together, what unites these different directions of research is an attempt to understand the development of spatial thinking as a problem solving process that relies in important ways on the context of performance, very broadly construed.

A final question that we as developmentalists ask is what develops and how? From an activity theory perspective, the development of spatial skill involves the ability to use space effectively both to solve problems and conduct meaningful activity, to be able to communicate this knowledge to others, and to learn to use the tools and practices of the culture to do these things. Investigating how these skills develop will require extensive examination of the contextual influences on the development of spatial thinking, and will therefore entail looking both inside and outside the head for evidence. This will not be easy. Our conventional tools and theories do not serve us as well in doing this as we would like. And, although it is becoming increasingly apparent that cognitive develoment is both an intrapsychological and interpsychological process, how these processes are related to and inform each other is far from clear. Nonetheless, I hope that I have illustrated how activity theory has aided me in the formulation of questions about the development of spatial thinking in everyday contexts. To summarize, I have used my time to argue that spatial thinking develops in meaningful, goal directed contexts that contain spatial, temporal, and sociocultural properties, and that everyday human spatial problem solving relies in important ways on assistance from other people, either in real or proxy form, and on tools and resources of the culture in which an individual participates. Better understanding of how children grow to become accomplished at this conglomeration and coordination of skills will, I believe, enrich our understanding of the development of spatial thinking. But in order to advance

such a dynamic, activity based view of spatial knowledge researchers will have to concentrate less on debating the nature of representations and attend more to how children and adults conduct activities in large-scale space, particularly when the space can be used in various ways to solve a problem. Such research may foster the examination of the emergence and development of spatial skill as it is integrated with human activity. And it may have the side benefit of better integrating spatial cognition with other aspects of cognitive development - an integration that is sorely needed.

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